Airport Design-3
Geometric Design

When designing airport runways, engineers and other planners have many factors to consider. These include the type and volume of air traffic, the impact of noise, and restrictions due to nearby developments such as residential developments, tall buildings, radio towers, etc.

* Design guidelines provided are according to the ICAO
Aircraft Dimensions

- Length: 79.750m (261.65 ft)
- Width: 30.372m (99.65 ft)
- Height: 7.142m (23.43 ft)
- Wing Span: 36.456m (119.67 ft)
- Nose to Tail: 51.400m (168.64 ft)

Door and location, ER 2-7.
Runway System
Runway System

(a) Structural Pavement
   Shoulder Blast Pad

(b) Runway Safety Area

(c) Runway Object Free Area

(d) Runway Protection Zone
Runway Visibility Zone and Sight Distance

**Figure 6-21** Runway visibility zone for intersecting runways (Federal Aviation Administration).
Airbus A340-600 Visibility from Cockpit
Runway (R/W) Cross Section

Figure 6-23 Runway gradient cross section.
Cross Section for R/W & T/W Area

NOTES:
1. CONSTRUCT A 1.5 IN [4 cm] DROP BETWEEN PAVED AND UNPAVED SURFACES.
2. MAINTAIN A 0.8% GRADE FOR 10 FEET OF UNPAVED SURFACE ADJACENT TO THE PAVED SURFACE.
3. S-3 APPLIES WHEN SHOULDER ARE PROVIDED.
4. S-4 SHOULD BE 5% OR NEGATIVE (LIMITED TO THE EDGE OF THE RUNWAY OR PRACTICAL ALLOWABLE POSITIVE SLOPE BASED ON AIRCRAFT DESIGN GROUP.
5. REFER TO FIGURE 4-30 FOR TAXWAY TRANSVERSE GRADES.

<table>
<thead>
<tr>
<th>APPROACH CATEGORY</th>
<th>A &amp; B</th>
<th>C, D, AND E</th>
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<tbody>
<tr>
<td>S-1</td>
<td>1.0%</td>
<td>1.0%</td>
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<tr>
<td>S-3</td>
<td>1.5%</td>
<td>1.5%</td>
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<tr>
<td>S-4</td>
<td>1.5%</td>
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<table>
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<tr>
<th>D-1</th>
<th>D-2</th>
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<tbody>
<tr>
<td>SEE TABLE 3-8</td>
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<table>
<thead>
<tr>
<th>S-4 (MAXIMUM)</th>
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<td>6:1</td>
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ICAO recommends the pavement width varying from 18m to 45m for different types of aircraft.

The width of runway pavement depends upon the transverse distribution of traffic at a distance from the center line of runway pavement. It is found that the aircraft traffic is more concentrated in the central 24m width of the runway pavements.

Another consideration in determining the runway width is that the outer most machine of larger jet aircraft using the airport should not extend off the pavement on to the shoulders. This is because the shoulder is usually of loose soil or established soil etc. which is likely to get into the engine and damage it.
R/W Adjacent Safety Area

- Safety area consists of the runway plus the shoulder on either side of runway plus the area that is cleared, graded and drained.

- The shoulder are usually unpaved or partially paved as they are used during emergency. The shoulders on the either side of runway impart a sense of openness to the pilot and improve his psychology during landing and take off.

- The length of the safety area is equal to the length of runway plus 120m.

- Width of safety area depends on the size of airport, the size of design A/C, and whether the R/W is Instrumental or Non-Instrumental (150 m for small A/P to a minimum of 300 m for air carrier A/P).
R/W Transverse Gradient

- R/W Transverse gradient is essential for quick drainage of surface water (1.5% to 2%)

- Shoulder Transverse gradient should not exceed 2.5% for the first 75 m from the centerline of the R/W to a maximum of 5% for the rest of the width
R/W Longitudinal Gradient

- Maximum Gradient should not exceed 1.5%
- Maximum Effective Gradient should not exceed 1%
- Rate of change of gradient is 0.1% (max) per 30m length of vertical curve.
- Distance between two successive points of grade intersections \( (L_{\Delta \text{min}}) \) should be >300\((|\Delta a| + |\Delta b|)\) meters
Longitudinal Gradient

- Max. grade change such as ‘a’ or ‘b’ should not exceed 1.5% for large Airports and 2% for small Airports.
- Length of vertical curve (L1 or L2) for each one percent grade change 300 m for large Airports and 90 m for small Airports.
- Rate of change of gradient is 0.1% (max) per 30 m length of vertical curve.
- Distance between two successive points of grade intersections (L_{\Delta min}) should be > 300 (I_{D aI} + I_{D bI}) meters.
NOTES:

1. MINIMUM LENGTH OF VERTICAL CURVES = 1,000 FT [305 M] x GRADE CHANGE (IN %).

2. THE MINIMUM VERTICAL CURVE LENGTH IS EQUAL TO 1,000 FT [305 M] x GRADE CHANGE.

3. THE MINIMUM DISTANCE BETWEEN POINTS OF VERTICAL INTERSECTION MUST BE 1,000 FT [305 M] x SUM OF THE ABSOLUTE GRADE CHANGES.
Taxiways (T/W)

- Taxiway provides access to the aircrafts from the runways to the loading apron or service hanger and back.
Factors to be considered for layout of taxiway

- Taxiway should be so arranged that the aircrafts which have just landed and taxiing towards the apron, do not interfere with the aircrafts taxiing for take-off.
- At the busy airport, taxiway should be located at various points along the runway so that the landing aircraft leaves the runway as early as possible and keeps it clear for use by other aircrafts. Such taxiway are called exit taxiway.
- The route for taxiway should be so selected that it provides the shortest practicable distance from the apron.
- As far as possible, the intersection of taxiway and runway should be avoided.
- Exit taxiway should be designed for high turn off speeds. This will reduce the runway occupancy time of aircraft and thus increase the airport capacity.
Geometric Design Standards for (T/W) According to ICAO

- Length – should be as short as practicable.

- Width – lower than the runway width. This is because the aircraft run on the taxiway are not airborne and the speed of the aircraft on taxiway is lower. Hence pilot can easily maneuver the aircraft over a smaller width of taxiway (22 m).

- Width of safety area – it includes width of taxiway pavement plus shoulder on either side. The width of the shoulder is 7.5m on each side and are paved with light strength material.

- Requirements for Longitudinal and Transverse Gradients for T/W are the same as those of R/W

- FAA recommends the transverse gradient of shoulder should be 5% for first 3m and 2% for thereafter
(T/W) Separation

\[ S_{TT} = WS + 2U_1 + C_1 \]  \hspace{1cm} (6-1)

where \( S_{TT} \) = minimum taxiway-to-taxiway or taxiway-to-taxilane separation
\( WS \) = wingspan of the most demanding aircraft
\( U_1 \) = taxiway edge safety margin
\( C_1 \) = minimum wingtip clearance

Therefore, for example, an ICAO aerodrome code letter E runway, which accommodates aircraft with wingspans up to 65 m, requires a taxiway centerline to a taxiway centerline or a taxilane centerline separation from Eq. (6-1) of \( 65 + 2(4.5) + 7.5 = 81.5 \) m.

The required separation between a taxiway centerline or an apron taxiway centerline and a fixed or movable object is found from Eq. (6-2).
\( S_{\tau_0} = 0.5 \, WS + U_1 + C_2 \)  \hspace{1cm} (6-2)

where \( S_{\tau_0} \) is the minimum taxiway or apron taxiway to a fixed or movable object separation and \( C_2 \) is the required clearance between a wingtip and an object.

The required clearance between a wingtip and an object \( C_2 \) is 4.5 m for aerodrome code letter A runways, 5.25 m for aerodrome code letter B runways, 7.5 m for aerodrome code letter C runways, and 12 m for aerodrome code letter D and E runways.

The required separation between an aircraft stand taxiway centerline and a fixed or movable object is found from Eq. (6-3).
Minimum turning radius: is very essential in order to decide the radius of taxiway, position of aircrafts in landing aprons and hangers and to establish the path of the movement of the aircraft.
Turning Radii

- Whenever there is change in direction of a taxiway, a horizontal curve is provided. The curve is so designed that the aircraft can negotiate it without significantly reducing the speed. Circular curve with larger radius is suitable for this purpose.

- The radius is given by \( R = \frac{V^2}{127f} \)
  where; \( R \) is radius in m, \( V \) is speed in kmph and \( f \) is 0.13 (side friction)

- Minimum \( R \) for Jet Transport is 120 m

- In Feet
  \( R_2 = \frac{V^2}{15f} \)
  \( L_1 = \frac{V^3}{CR_2} \)
  where \( V \) is in feet per second, \( R_2 \) is in feet, and \( C \) was found experimentally to be on the order of 1.3.
Turning Radii

\[ R_1 = \text{radius of entrance curve} \]
\[ L_1 = \text{length of entrance curve} \]
\[ R_2 = \text{radius of central curve} \]